PROGRESS REPORT 3/16/61 - 4/15/61
CONTRACT NO. AF 33(600)40280

SYSTEM

All known problems associated with system concept and physical integration have been resolved. These included the following decisions:

1. The antenna integral radome has been replaced with a separate more conventional radome. Minor physical modifications are required and installation procedures resolved. A sample of the radome asbestos honeycomb material has been received for electrical test. The initial tests of the antenna array disclosed a vertical lobe which was only 10 db down. It was established that due to the focusing action of the display, a 15 db image would be tolerable. Computer runs have established that this reduction can be accomplished by adding two slots.
2. Design requirements for the accelerometer circuits to determine compensating signals for effects of platform instability have been completed and circuits designed. Information obtained from the April meeting of the High Resolution Radar Committee meeting held at Hughes Aircraft indicated the University of Michigan experience has led them to condlude that platform motion compensation should be done in the manner in which we planned.

The requirements for the degree of compensation likewise appeared to agree with our estimates.

3. Suitable space requirements for all major components has been established. This resulted in some modification of the layouts for two major components. The layout of the frame to accommodate all major assemblies (except the antenna) into one system assembly which can then be handled as a unit is well under way and an engineering mark up of this arrangement is to begin next week.

There is still a need to resolve the contractual procedures for integrating into the system the decision to provide certain auxiliary flight data by means of a separate synchronized camera. It is anticipated this will be resolved within the next reporting period.

It has become evident that the gain of the ring duplexer which was specified in the design specification cannot be met in the time schedule required, if at all. Somewhat lesser gain can be obtained however and the most expeditious manner to proceed is being determined. This is explained in more detail later in the report. The switches required are somewhat behind schedule and dependent upon any decisions resulting from the ring duplexer problems. As a result the design for the switch drivers are held up pending resolution of the switch drive requirement. It may be necessary to proceed with the driver design on the basis of a calculated risk.

Because of internal manpower problems it has not been possible to attack the problem of laboratory evaluation and a flight test program with the aggressiveness desired. Some incidental work has been done in certain areas, including a study of the physical problems associated with the "railroad". At this time its capabilities do not appear to warrant its complexity and expense. The manpower problem is expected to be resolved within a week.

A wooden mock-up of the antenna is essentially complete as is the modulation KPA.

SYNCHRONIZER

Frequency - Generator

The variable-frequency oscillator section has been built, tested and the desired output has been obtained. Drafting is now converting the breadboard design to production drawings.

The fixed-frequency oscillator section is approximately 90% built and testing will begin the week of 4/17.

Work has begun on the IF section. Some oscillation difficulties have impeded progress here but should be cleared up within a week.

After lengthy negotiation with Bulova, the oscillator-discriminator package height was changed so that the package could be made a part of the frequency-generator chassis instead of being located in another area and interconnected by long drive leads. Delivery dates of 5/1/61 for the breadboard and 5/8/61 for prototypes are still promised.

The D-C amplifier is now being breadboarded in its final form. Difficulties associated with supply voltage variations, types of feedback, and injection points for the navigation tie-in and accelerometer inputs have been resolved.

A re-layout of the frequency generator package has been made. This was done to provide better protection from stray magnetic fields for the recorder CRT.

To follow up a suggestion by [redacted] that a voltage controllable crystal oscillator might be supplied by [redacted] a telephone call was made to [redacted] on February 24, 1961, explaining our Frequency-Generator problem. He agreed to send a letter outlining their approaches to this problem, including approximate costs and time they would require for each approach suggested. 25X1 25X1 25X1

His suggestions in this order, were:

(1) They could easily do it.

(2) They would furnish oscillator at say 5 mc, and we translate it to 120 mc by modulation.

(3) They would furnish approximately 5 mc oscillator and we multiply output to 120 mc.

On March 7, 1961 [redacted] was again contacted and our problem was restated to a [redacted] with similar reaction and identical results. This was followed by a letter to [redacted], on April 5, 1961. No reply has been received. 25X1 25X1 25X1

Synchronizer-Generator

Schematic and tape master for one of two printed circuit boards has been completed. Drawings for this board are now being checked.

Drafting is now working on the second printed circuit board. Drafting work on this board is approximately 40% completed.

Temperature tests have been performed on engineering models of both printed circuit boards over the range of +55°C to -54°C. Performance seemed to be entirely satisfactory and within the unit specification.

A breadboard model of the 13 mc oscillator has been received and checked. The harmonic distortion was found to be 10% instead of 1%. This unit will be returned to the supplier.

Long lead items on the synchronizer generator have been ordered.

STALO ASSEMBLY

Modification drawings of the phase detector of the microwave oscillator are nearing completion. Layout of the receiver RF assembly was completed.

A VA-401 klystron amplifier which is used on the KPA driver has been received from Varian Associates. As measured in the laboratory the gain of this tube was 29 to 30 db when the input is one or more milliwatts, even at supply voltage reduced to 800 volts. This should be ample gain.

NAVIGATION TIE-IN

Drift Speed Unit

A breadboard of the drift angle gear box on which a geared servo motor precision potentiometer and a synchro resolver are mounted has been completed. The precision potentiometer has been ordered and received.

Detail and assembly drawings for the servo amplifier and the gear box are completed. However Bowmar Instrument Corporation has finally submitted a drawing of a proposed servo motor-gear box-potentiometer assembly which is more compact than the unit designed here. A decision to use our own design or that of Bowmar is being evaluated.

A step servo motor-gear box-potentiometer assembly for velocity follow has been ordered from Bowmar Instrument Corporation. Control rectifier switches to be used to drive the step servo motor have been ordered.

Accelerometer Unit

This is a device which will detect antenna acceleration in the direction of radiation at modulating frequencies from 0.1 cps to about 5 cps.

It was desirable to have the accelerometer located on the antenna but the environment there is much too severe for any known sensor. However investigation has disclosed that the accelerometer can be located with the electronic gear and still provide the desired information, except for one part of the vibration spectrum. In this area accelerations exist which are higher than tolerable and which do not exist at the antenna so the output of the sensor must be filtered to eliminate these spurious signals. At the moment this is believed to be a detail design problem and not a fundamental system problem.

A network-summing amplifier into which the output of the drift speed and accelerometer units feed, is now being designed. The crossover between the units is 0.1 cps.

A P.D.C. for an accelerometer sensor, Model 4310, manufactured by Donner Scientific Company is nearly completed. Work has begun on the breadboards containing the operational amplifier, modulator output amplifier and power supply. Schematics and tentative parts lists of the above 3 units have been given to drafting.

RECEIVER

A new tube (S/N 5963) to replace first defective tube was received on April 4, 1961. It had a noise figure of 7.5 db according to the manufacturer (G.E.) and our own measurements indicated an 8 db figure. The gain was measured at approximately 32 db. Both measurements indicate reasonable agreement with quoted values. As a further test the tube was cut off with a 2 usec pulse and output observed on scope with satisfactory results. Further tests will be made to determine the attenuation when tube is cut off.

A second tube (S/N 5922) with noise figure of 6.8 db received on April 10, 1961 and by our measurements was found to have a noise figure measurement of 7.0 db.

Layout of the IF amplifier was completed and detailed parts drawings are being made. The debugging and testing of the engineering design model of this unit is 90% complete and no major changes will be necessary. A slight redesign of the interstage networks was necessary due to the larger stray circuit capacity in the circuit layout. The last five stages of the IF amplifier are now being automatic gain controlled and will make unnecessary automatic gain control of the video amplifier.

The electrical design and mechanical layout of the video amplifier is complete. Distributed amplifier techniques are used here. A breadboard four section stage was built and performed satisfactorily. The prototype model has been constructed and alignment and testing of this is now in progress. The original design which had the video amplifier automatic gain controlled has been changed and the control voltage is now being applied to the IF amplifier.

The electrical design and mechanical layout of the synchronous mixer have been completed. Results of experimental investigation of a breadboard circuit show satisfactory operation but indicate that some minor changes may be needed when the mixer is combined with the video circuits. Specifically, more isolation may be required between the local oscillator and mixer input and more suppression of the local oscillator signal in the mixer output may be necessary. Construction of the prototype is complete as part of the video amplifier and testing of this is now under way.

POWER SUPPLY AND CONTROL

The control panel was released to drafting on March 27, 1961 and should be finished by April 20, 1961. Bids will be sent out to edge lighted panel manufacturers on April 17, 1961. No problems are expected on illuminating the panel at this time.

The known information on the power supply was released to drafting on March 27, 1961. However, the physical size of the subassemblies are not completely established as of this date, with the result that drafting is unable to start work on the final layout and drafting of the power supply.

The ambient temperature surrounding the power supply subassemblies was changed from the 78°F to 100°F, to 0°C to 49°C so that temperature conditions that could exist under some ground operating periods would not require unusual cooling requirements.

MODULATOR

Drafting has completed and released all drawings except the wiring diagram. This will be completed on schedule.

The klystron filament transformer was shipped by Raytheon on April 13, 1961.

Burmac had a capacitor burn out in final testing of the 7.5 KV power supply and is held up pending receipt of a replacement. Tests required the PFN to be changed from a 5 section to a 10 section network in order to meet the pulse flatness spec. These tests indicated the rise time specification can be met. Burmac has reached the point where the pulse is satisfactory using a load resistor and capacitor to approximate the actual load. Because the actual modulator and klystron load should be used to complete optimizing the network, arrangements will be made to test the network with the breadboard modulator and a V2h8 which is available.

RESONANT RING DUPLEXER

Airtron, by letter of April 11 reported that because they are unable to meet specifications they are not in a position to quote on additional models of the resonant ring in circular mode to Westinghouse. Airtron now feels the circular mode resonator is not feasible and have quoted, as an alternate solution, to build a resonant ring in square waveguide, hopefully expecting 0.014 db/ft attenuation which would provide a 15 to 20 power multiplication. To quote Airtron letter "although this is somewhat below the desired value, it seems to be the optimum value that can be achieved at the present state of the art". Price was quoted at $6,000.00 each.

Westinghouse has begun work on investigation of a filter type, standing-wave resonant ring. This type resonator will be tested some time in the week ending 4/23/61. A comparison of the four methods of resonant ring design is included at the end of this report.

To date no quote has been received from Microwave Associates on the dump switches. As previously mentioned, no bid was entered by Bomarc, Sylvania, or Don-Lan.

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A method of simultaneous waveguide switch firing by ultraviolet light from a voltage discharge is being investigated. Preliminary results look promising.

Westinghouse has shortened the S.E.I. ring in Baltimore to approximately 12 nanoseconds and an attempt is being made to replate hybrids which were badly pitted. No pitting occurs when silverplating is rhodium flashed.

A preliminary design for an automatic peak power monitor has been breadboarded, and seems to be quite adequate for monitoring lower limit of acceptable peak power. One tunnel diode and two transistors are employed in circuit.

Circular Cross-Section Ring Resonator	Rectangular Cross-Section Ring Resonator	Square Cross-Section Ring Resonator	Filter Standing Wave Resonator
13-14 db gain theoretical	10-11 db gain theoretical	12-13 db gain theoretical	Gain not yet determined, but in its simplest form, should yield approximately 10 db.
Self-duplexing			No self-duplexing with one switch. Self-duplexing with two switches.
2 switch tube required each to hold off 250 KW must fire simultaneously			500 KW holdoff required in simplest form, only one switch required.
Requires minimum of 5 couplers & hybrids			Requires 1 iris, 1 3 db hybrid if 500 KW holdoff tube is developed 2 3 db hybrids if 250 KW holdoff is used.
Shorts very good due to lack of longitudinal currents.	Shorts lossy		Shorts lossy
4 alum. shorts, each approx. 1 inch long, can be used to temperature compensation			1 short, approx. 4 inches long; support could be a problem.
Problems			
TE_{10} to TE_{01} launcher	Waveguide conductivity losses due to longitudinal currents		RF breakdown power most severe due to standing waves.
	RF breakdown		Main advantage realized when used in simplest form i.e. 500 KW switch, not self duplexing. Requires two waveguide circulators.
		spurious orthogonal mode possible	

SECRET

SWITCH TUBES

During the first part of the period, a tube consisting of thin walled waveguide with a glass capsule and pulsed magnetic field was assembled and tested. It was demonstrated that a pulsed magnetic field could be used to trigger the plasma within the capsule. For these tests, an incident power of 60 KW peak was used which resulted in plasma breakdown times of 20 ns.

Control was not complete, however, in that the trigger pulse (the magnetic field) could not be positioned in a manner that would delay the breakdown time to a specified point within the r.f. pulse width. Another fault observed was that the field strength was not equal to that required for cyclotron resonance. Consequently, other magnetic pulsing techniques are being sought.

Another experiment was performed with the same tube but minus the pulsed magnetic field. In place of a pulsed field, a d.c. field of 2300 gauss was used. The results of this test were very interesting in that a breakdown time of 20 ns was observed and the breakdown time could be delayed to any point within the r.f. pulse width merely by changing the value of d.c. field strength. As the delay between the rise time of the r.f. pulse and the switched fall time was increased, the breakdown time increased from 20 ns to 30 ns.

A complete investigation of the switching possible with a d.c. magnetic field is being made. In addition, work is continuing with pulsed magnetic fields.

ANTENNA

Electrical

Verification of all transitions and miters for manifold #3 and #6 is complete. Testing of the remaining pieces is continuing.

A 24" model manifold has been fabricated and will be used with a set of 24 sticks as soon as the stick design is complete. Twenty-four stick "blanks" have been fabricated and are ready for the slots to be cut in order to shorten the lag between design and test verification of stick designs.

The final load configuration has been discussed with the suggested supplier who has verified his design with the correct mounting. A sample of this load has been shipped but not yet received.

Mechanical

The outline of the honeycomb beam was revised as a result of the removal of the radome. The end use drawing has been released to the vault and an EAM released to the Model Shop. Formal quotes have been requested by April 19, 1961, with delivery to be August 1, 1961.

The end use manifold drawings have been released to the vault and an EAM released to the Model Shop. Requested delivery date is July 15, 1961.

The array mechanical design is complete with the exception of the location of the slots. The end use drawing will be started when this information is available. Tensile test specimens of electroformed nickel used in the array have been sent to Westinghouse Research Labs for tensile tests at 550°F. Results are expected within one week.

Removal of the radome, reducing the thickness of the honeycomb and moving one of the mounts necessitated a new computer run to assess the effect on the RF patterns. The results of this computer run indicate that the changes have not caused a deterioration of the patterns.

The aerodynamic skin radome has been removed from the antenna as requested. This action has caused the revision of many of the end use drawings and will cause a delay of a week or two in the release of these drawings. A slotted waveguide array stick has been successfully sealed and remained pressure-tight through four cycles of temperature fluctuations from 70 degrees to 550 degrees F. Material numbers have been assigned to the materials used and a process spec for the sealing procedure is being written. The sealing investigation is continuing to perfect the bonding technique and to explore an alternate method of sealing which would greatly reduce the cure time that is now required in the present bonding method.

The purchase part drawing of the load has been completed and an RFA written to the Model Shop. The "O" ring investigation is continuing in order to find an acceptable "O" ring. So far, the "O" rings would deteriorate after exposure to the high temperatures required. Two new compounds are being molded and will be tested along with some changes to the "O" ring groove.

Most of the drawings of the antenna assembly and its details have been made and are in the process of being checked and corrected. Drawings will be released and RFA's written as soon as each drawing becomes available.

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RECORDER (Copy-Figures not included)

General

During the month of March, we completed our design study for the film drive. Our study showed a reduction in the weight of the drive components would be achieved by the adoption of a 400 cycle hysteresis motor. Also, we have decided to use D.C.torque motors on the film reel spindle working in opposition to a drive or metering roller which will pull the film from the reel.

On the electronic side, we received the Celco yoke and were able to complete our work on the jumpscan. Work on the flashlamp illumination system was completed through the breadboard stage for the data projection system.

Our photographic work during the report period was directed at finding a suitable lubricant that could be applied to the film in the recorder before the film moves into contact with the fiber optics. Some interesting results have been obtained.

A meeting of Westinghouse and Itek Laboratories technical representatives was held at Itek on March 28th. A complete specification review was conducted and resulted in an agreement to initiate certain specification changes for the purpose of better definition and understanding of the scope of work.

Both the Cathode Ray Tube and Fiber Optic array deliveries have been delayed two to four weeks. This represents a serious problem in our attempt to meet an October 1st delivery date for the first recorder.

Mechanical

As a result of our breadboard testing of the film drive system, we found that it would be desirable to change our approach to the method of feeding film from the supply reel. Our design now uses a drive roller to meter the film from the reel, feeding the film into a free loop which isolates the supply reel from the film drive system in the exposure area. Figure 1 (Itek 9134-9042) shows the overall film drive system.

The design layouts for this drive have been completed and released to drafting for detailing. The motors for these drives have been ordered.

As mentioned previously, the capstan drive motor is now a 400 cycle hysteresis synchronous motor. One advantage for the 400 cycle motor over its 60 cycle counterpart is the reduction of weight (approximately 33%) and a possible reduction in weight in the inverter used to convert 28 volt D.C. to 400 cycles (9-1/2 lbs. for the 60 cycle inverter). The increased speed of the 400 cycle motor (from 1200 RPM to 6000 RPM) required a change in the speed reduction belt-and-pulley system which drives the capstan. The design layout of the capstan drive system has been completed and is now being detailed in drafting.

The torque motors are 28 volt D.C. motors coupled directly to the film reel shafts. The design layout of this part of the system has also been released to drafting for detailing.

As a part of our study of the data projection system, we completed both the optical, electrical and to a certain extent, the photographic breadboard tests during the report period. We have now started a layout of the data input projection system. A battery driven, 24 hour watch has been ordered from the Hamilton Watch Company for use in this display.

As a result of suggestions offerred by Westinghouse at a meeting at Itek on March 28th, we are seeking to improve the Cathode Ray Tube mounting details. As one result, we have changed the method of mounting the yoke to the supporting frame. Release for fabrication of these details is being held up until these changes are accomplished.

A new study of the vibration and shock isolation problem was started when it became apparent that vibration isolation to 1 or 2 cycles per second would use approximately 15% of the overall allowable weight and also take considerable volume. Our present goal is isolation down to 8 cycles per second using standard vibration and shock mounts. The entire recorder will be supported on these to make use of the available sway space, rather than attempting to mount the frame internally to the outer skin of the recorder. This would severely restrict the available sway space.

At the meeting of Westin house at Itek on March 28th, we were informed that the video amplifier to be supplied by Westinghouse will be approximately 4 x 4½ x 10 or 12 inches. It may be possible to mount this unit external to the recorder. A decision on this will be made as soon as information is received from Westinghouse as to the exact dimensions.

Electronic

We received the yoke from Celco during the report period and have tested it with the triangular scan with good results. We still have to test the linearity of the scan with this yoke, but hope to accomplish this when we receive the CRT. We have completed the step scan circuit design; the technical details of this circuit are discussed in a technical report in the appendix of this report.

Work was started on the design of coils to adjust the CRT beam position. We have constructed a breadboard unit for testing purposes which performs satisfactorily. Drawings are now being prepared for submission to vendors for quotes on the fabrication of the final unit. Technical details are discussed further in the appendix.

We have tested a Clairex CL 602 photoconductive cell as a possible means to monitor the light of the CRT. This cell has ample sensitivity for the task; however, its temperature characteristics may cause some difficulty.

Final packaging design for the electronic package was began during the last week of the report period. This work will keep pace with the mechanical design of the overall recorder. Figure 2 shows a block diagram of the electronic system.

Photographic

During the month we started a study of methods of providing lubrication for the film as it passes over the fiber optic array. One method that is being considered is a thin coat of Teflon applied to the fiber optics; however, there is some doubt as to how well this coating will wear. Another